4. [X] Priority is hereby claimed under Rule 55 and 35 USC 119 based on prior foreign application(s) No(s): 250340/84 filed in (country) Japan on (date) November 26, 1984.

a. [ ] Certified copy(s) attached.

[X] Certified copy(s) already filed on February 26, 1988 in prior United States Serial No. 07/092,130, filed on September 2, 1987.

5. [X] The prior application is assigned to Semiconductor Energy Laboratory Co., Ltd..

6. [X] The Power of Attorney in the prior application is to:

Gerald J. Ferguson, Jr.	Reg. No. 23,016
Robert B. Murray	Reg. No. 22,980
Fred S. Whisenhunt	Reg. No. 24,378

a. [X] The Power appears in the original papers of the prior application.

b. [ ] Since the Power does not appear in the original papers of the prior application, a copy of the Power is enclosed herewith.

7. [ ] Address all future communications to:

SIXBEY, FRIEDMAN, LEEDOM & FERGUSON, P.C.
2010 Corporate Ridge, Suite 600
McLean, Virginia 22102

8. [X] Amend the specification by inserting before the first line the sentence --This is a Divisional application of Serial No. 08/659,636, filed June 6, 1996; which itself is a division of Serial No. 08/351,140, filed November 30, 1994; which is a continuation of Serial No. 08/064,212, filed May 12, 1993, now abandoned; which itself is a division of Serial No. 07/842,758, filed February 28, 1992, now abandoned; which is a continuation of Serial No. 07/092,130, filed September 2, 1987, now

abandoned; which is a division of Serial No. 06/801,768, filed November 26, 1985, now abandoned.--

9. [X] Cancel claim 2_____.
(DO NOT CANCEL ALL CLAIMS)

10. [ ] Status as a Small Entity is requested. Executed Small Entity Declaration(s)
[ ] is/are attached.
[ ] was/were filed in prior application on _____
_____.

11. [X] The filing fee is calculated below:

Claims as originally filed, less any claims above cancelled.

For:	No. Filed	No. Extra	Rate	Fee
Basic Fee				$770.00
Total Claims	1 - 20 =	0	x 11/22	
Indep Claims	1 - 3 =	0	x 40/80	
[ ] Multiple Dependent Claim			+ 130/260	
			TOTAL	$770.00

12. [X] Preliminary Amendment attached, to be entered at once.

Total claim fee calculated after amendment:

Total Claims	32 - 20 ** =	12	x $11/22****	$264.00
Independent Claims	8 - 3 ***=	5	x $40/80****	$400.00
[X] Multiple Dependent Claim			+ 130/260	$260.00
			Total Amendment Fee	$924.00
			Total Filing Fee (from paragraph 11)	$770.00

A #

Docket: 0756-1717
Date: September 9, 1997

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

REQUEST FOR FILING

[ ] Continuation)
) application under 37 CFR 1.60 (Rule 60)
[X] Divisional)

of pending prior application of

Applicant: Shunpei YAMAZAKI
Serial No.: 08/659,636 Group Art Unit: 1109
Filed: June 6, 1996 Examiner: M. Whipple
For: LAYER MEMBER FORMING METHOD

Honorable Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

To effect the above-requested filing today:

1. [X] Attached is a true copy of the prior application as filed, including
[X] Specification and claims as originally filed;
[X] Declaration or Oath as originally filed;
[X] 1 sheet of formal drawing as originally filed

2. [X] The Commissioner is hereby authorized to charge fees under 37 CFR 1.16 and 1.17 (except the Issue Fee) which will be required now or hereafter, or credit any overpayment, to Deposit Account No. 19-2380. A duplicate copy of this form is attached.

3. [ ] Transfer the drawings from the prior application to this application and abandon said prior application as of the filing date accorded this application.

TOTAL FEE $1,694.00

13. [X] A check in the amount of $1,694.00 to cover the TOTAL FEE is enclosed.

14. [ ] No fee is enclosed. The filing fee will be submitted later.

15. [X] The Commissioner is hereby authorized to charge fees under 37 CFR 1.16 and 1.17 (except the issue fee) which may be required now or hereafter, or credit any overpayment, to Deposit Account No. 19-2380. A duplicate of this form is attached.

16. [X] It is hereby petitioned under 37 CFR 1.136 that the response term in the prior pending application be extended, if necessary, to a date which includes the filing date of the present application, and the Commissioner is hereby authorized to charge any necessary extension fee to Deposit Account No. 19-2380.

Respectfully submitted,

Gerald J. Ferguson, Jr.
Registration No. 23,016

Sixbey, Friedman, Leedom & Ferguson, P.C.
2010 Corporate Ridge, Suite 600
McLean, Virginia 22102
(703) 790-9110

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT Application of	)	
Shunpei YAMAZAKI	)	
Based On Serial No. 08/659,636	)	Art Unit: 1109
Which Was Filed: June 6, 1996	)	Examiner: M. Whipple
For: LAYER MEMBER FORMING	)	
METHOD	)	Date: September 9, 1997

PRELIMINARY AMENDMENT

Honorable Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please preliminarily amend the subject application as follows:

IN THE CLAIMS:

Cancel claim 1 and add new claims 3-20 as follows:

--3. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form an insulating film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a conductive film by vapor deposition on said insulating film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

4. The method of claim 3 wherein said insulating film comprises a material selected from the group consisting of silicon nitride, SiO2, phosphate glass, boronsilicate glass and aluminum nitride.

5. The method of claim 3 wherein said conductive film comprises a material selected from the group of consisting of aluminum, iron, nickel and cobalt.

6. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form an insulating film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a metal silicide film by vapor deposition on said insulating film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

7. The method of claim 6 wherein said insulating film comprises a material selected from the group consisting of silicon nitride SiO2, phosphate glass, boronsilicate glass and aluminum nitride.

8. The method of claim 6 wherein said metal silicide film comprises a material selected from the group of consisting of SiMx (where O<x<4 and M is such a metal as Mo, W, In, Cr, Sn or Ga).

9. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a semiconductor film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a conductive film by vapor deposition on said semiconductor film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

10. The method of claim 9 wherein said conductive film comprises a material selected from the group consisting of aluminum, iron, nickel and cobalt.

11. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a semiconductor film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a metal silicide film by vapor deposition on said semiconductor film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

12. The method of claim 11 wherein said metal silicide film comprises a material selected from the group of consisting of SiMx (where O<x<4 and M is such a metal as Mo, W, In, Cr, Sn or Ga).

13. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a first insulating film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a second insulating film by vapor deposition on said first insulating film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

14. The method of claim 13 wherein said first and second insulating film are different type.

15. The method of claim 13 wherein said first and second insulating film are same type.

16. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged, substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a SiO2 film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a phosphate glass film by vapor deposition on said SiO2 film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning

on at least a portion of said pair of electrodes.

17. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a SiO2 film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a boronsilicate glass film by vapor deposition on said SiO2 film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

18. A vapor reaction method comprising the steps of:

preparing a pair of first and second electrodes within a reaction

chamber, said pair of electrodes being arranged substantially in parallel with each other;

placing a substrate in a reaction chamber on said first electrode so that a first surface of said substrate faces toward said second electrode;

introducing a first film forming gas into said reaction chamber through said second electrode;

exciting said first film forming gas in order to form a first conductive film by vapor deposition on said substrate placed in said reaction chamber;

introducing a second film forming gas into said reaction chamber through said second electrode;

exciting said second film forming gas in order to form a second conductive film by vapor deposition on said first conductive film in said reaction chamber;

removing said substrate from said reaction chamber after said vapor deposition;

introducing a cleaning gas into said reaction chamber through said second electrode;

exciting said cleaning gas in order to perform a plasma cleaning on at least a portion of said pair of electrodes.

19. The method of claims 3, 6, 9, 11, 13, 16, 17 or 18, wherein said cleaning gas is a fluoride.

20. The method of claims 3, 6, 9, 11, 13, 16, 17 or 18, wherein said fluoride is nitrogen fluoride.--

REMARKS

New claims 3-20 have been added in this division application to complete the scope of applicant's protection.

Examination on the merits is requested.

Respectfully submitted,

Gerald J. Ferguson, Jr.
Registration No. 23,016

Sixbey, Friedman, Leedom & Ferguson, P.C.
2010 Corporate Ridge, Suite 600
McLean, Virginia 22102
(703) 790-9110

S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN

BE IT KNOWN THAT I, Shunpei Yamazaki, a subject of Japan, residing at Setagaya-ku, Tokyo, Japan have invented certain new and useful improvements in

"LAYER MEMBER FORMING METHOD"

of which the following is a specification.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a layer member forming method which is suitable for use in the fabrication of various electronic devices of the type having an insulating, protecting, conductive, semiconductor or like layer member formed on a substrate member.

Description of the Prior Art

Heretofore there has proposed a method for forming such a layer member on a substrate member through use of a photo CVD or plasma CVD process.

According to the method utilizing the photo CVD technique, the substrate is placed in a reaction chamber provided with a light transparent window and a reactive gas mixture, which contains at least a gas of a material for the formation of the layer member desired to obtain, is introduced into the reaction chamber. Then light is introduced into the reaction chamber through the light transparent window thereof by which the reactive gas mixture introduced thereinto is excited for vapor-phase decomposition and the material for the layer is deposited on the substrate member.

With the method utilizing the plasma CVD

technique, the substrate is placed in a reaction chamber and a reactive gas mixture, which contains a gas of a material for the formation of the layer, is introduced into the reaction chamber. In the reaction chamber the reactive gas mixture is excited into a plasma by grow discharge or electron cyclotron resonance for vapor-phase decomposition by high frequency electric power so that the material for the layer is deposited on the substrate.

With the photo CVD process, since the material gas resulting from the vapor-phase decomposition of the photo-excited reactive gas is not accelerated, it is possible to form the layer on the substrate with substantially no damage inflicted on the substrate surface. On this account the layer can easily be formed without containing the material forming the substrate surface or without introducing into the substrate surface the material forming the layer, without developing any undesirable interface level between the layer and the substrate and without applying any internal stress to the layer and the substrate. Furthermore, since the photo-excited material gas has a characteristic to spread on the surface of the substrate member, the layer can be deposited in close contact with the substrate even if

the substrate surface is uneven.

Accordingly, the use of the photo CVD technique permits easy formation of the layer of desired characteristics, without causing any damages to the substrate surface, even if the substrate has an uneven surface.

With the photo CVD process, however, since the photo-excited material gas is not accelerated toward the substrate, the deposition rate of the layer is lower than in the case of employing the plasma CVD technique. Therefore, the photo CVD process takes much time for forming the layer as compared with the plasma CVD process. Furthermore, the material for the layer is deposited as well on the light transparent window during the formation of the layer, causing a decrease in the light transmittivity of the window as the deposition proceeds. Therefore, the layer cannot be formed to a large thickness. For instance, in the case of forming a silicon nitride layer, it is difficult, in practice, to deposit the layer to a thickness greater than 1000 A. Moreover, difficulties are encountered in forming a silicon layer to a thickness greater than 200 A, a silicon oxide (SiO_2), or aluminum nitride (AlN) layer to a thickness greater than 3000 A, a silicon carbide (Si_xC_{1-x},

where 0 < x < 1) layer to a thickness greater than 500 A and a germanium silicide (Si_xGe_{1-x}, where 0 < x < 1) or metal silicide (SiM_x, where M is metal such as Mo, W, In, Cr, Sn Ga or the like and 0 < X ≤ 4) layer to a thickness greater than 100 to 200 A.

With the plasma CVD process, since the material gas resulting from the vapor decomposition of the reactive gas excited by electric power can be accelerated toward the substrate, the deposition rate of the layer is higher than in the case of using the photo CVD process. Therefore, the layer can be formed on the substrate in a shorter time than is needed by the photo CVD technique. Furthermore, even if the material for the layer is deposited on the interior surface of the reaction chamber as well as on the substrate, no limitations are imposed on the excitation of the reactive gas by electric power. Consequently, the layer can easily be formed to a desired thickness on the substrate.

With the plasma CVD technique, however, since the material gas excited by electric power is accelerated by an electric field, it is difficult to deposit the layer on the substrate without causing damage to its surface. On account of this, the layer contains the material forming the substrate surface,

or the substrate surface contains the material forming the layer. Moreover, an interface level is set up between the layer and the substrate and internal stresses are applied to the layer and the substrate.

Besides, in the case of employing the plasma CVD technique, since the excited material gas is accelerated by an electric field and its free running in the reaction chamber is limited, there is the possibility that when the substrate surface is uneven, the layer cannot be formed in close contact therewith, that is, the layer cannot be deposited with desired characteristics.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a novel layer member forming method which is free from the abovesaid defects of the prior art.

The layer member forming method of the present invention comprises the steps of depositing a layer of a desired material on a substrate by the photo CVD technique and depositing on the first layer a second layer of a material identical with or different from that of first layer by the plasma CVD technique, thereby forming a layer member composed of at least

the first and second layers.

According to such a method of the present invention, since the first layer is deposited by the photo CVD technique on the substrate, even if the substrate surface is uneven, the first layer can be deposited in close contact with the substrate surface and with substantially no damage thereon. Accordingly, the first layer does not substantially contain the material forming the substrate surface, or the substrate surface does not substantially contain the material forming the first layer. Further, the deposition of the first layer is not accompanied by provision of an undesirable interface level between the first layer and the substrate and the application of internal stresses to the first layer and the substrate. In addition, since the second layer is deposited by the plasma CVD technique on the first layer, the second layer can easily be formed to a desired thickness in a short time.

In accordance with an aspect of the present invention, by forming the first and second layers as insulating, protecting or conductive layers of the same or different types or compositions, the layer member as a insulating, protecting or conductive layer member of desired characteristics can easily

be deposited to desired thickness in a short time without inflicting damage on the substrate surface.

In accordance with another aspect of the present invention, by forming the first and second layers as semiconductive layers of the same type or composition, the layer member as a semiconductor layer member can easily be deposited to a desired thickness in a short time without inflicting damage to the substrate surface.

In accordance with another aspect of the present invention, by forming the first and second layers as semiconductor layers of different types or compositions, the layer member can easily be deposited as a semiconductor layer member composed of a first semiconductor layer which may preferably be relatively thin and a second semiconductor layer which may preferably be relatively thick, in a short time without causing damage to the substrate surface.

In accordance with another aspect of the present invention, by forming the first and second layers as an insulating layers and as a conductive or semiconductor layer, respectively, the layer member as a composite layer member can easily be deposited including a conductive or semiconductor layer formed to a desired thickness on the insulating layer of the

least possible thickness, in a short time without impairing the substrate surface.

In accordance with yet another aspect of the present invention, by forming the first and second layers as a conductive or semiconductor layer and as an insulating or protecting layer, respectively, the layer member as a composite layer member can easily be deposited including an insulating or protecting layer formed to a desired thickness on the conductive or semiconductive layer of the least possible thickness, in a short time without impairing the substrate surface.

Other objects, features and advantages of the present invention will become more fully apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying sheet of a drawing schematically illustrates an example of the layer forming method of the present invention and an example of apparatus used therefor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will be given first of an apparatus for the formation of a layer member according to the present invention.

The apparatus has a conductive reaction chamber 10. The reaction chamber 10 is provided with a plurality of conductive nozzles 11 arranged at the lower portion of the chamber 10 and each having upper and lower nozzle parts 12a and 12b. The conductive nozzles 11 are connected to one end of a power supply 15 for gas excitation.

A gas introducing pipe 13 is connected to the upper nozzle parts 12a of the nozzle 11 and extends out of the reaction chamber 10. The gas introducing pipe 13 is connected to a gas source 14A via a valve 15A and a flowmeter 16A and to another gas source 14B via a valve 15B and a flowmeter 16B.

Another gas introducing pipe 17 is connected to the lower nozzle parts 12b of the nozzle 11 and extends out of the reaction chamber 10. The gas introducing pipe 17 is connected to a gas source 18A via a valve 18A and a flowmeter 20A, to a gas source 18B via a valve 19B and a flowmeter 20B and to a gas source 18C via a valve 19C and a flowmeter 20C.

The reaction chamber 10 is provided with an exhaust pipe 21 which extends to the outside through the bottom wall of its extending portion 10' wherein the nozzles 11 are not placed. The exhaust pipe 21 is connected to a vacuum pump system 22 via a control

valve 23 and a change-over valve 24. The vacuum pump system 22 has a tandem structure of a turbo pump 25 and a rotary pump 26.

Provided on the bottom wall of the reaction chamber 10 is a light source chamber 30, in which is disposed light sources 31 each of which emits light having a wavelength 300nm or less, such as a low pressure mercury lamp. The light sources 31 are connected to an external power supply (not shown). Provided on the bottom wall of the chamber 30 are cooling pipes 51 which are connected to a cooling tower (not shown).

The reaction chamber 10 and the light source chamber 30 optically intercommunicate through a window 33 made in, for instance, a quartz plate disposed therebetween.

The light source chamber 30 has a gas introducing pipe 34 which extends to the outside through its one end portion of the bottom wall. The gas introducing pipe 34 is connected to a gas source 35 via a valve 36 and folwmeter 37. The light source chamber 30 has an exhaust pipe 38 which extends from the other end portion of the bottom wall of the chamber 30 into the extending portion 10' of the reaction chamber 10. A heater 39 is provided on the

exhaust pipe 38.

Disposed on the upper wall of the reaction chamber 10 is a heat source chamber 40, in which is disposed a heat source 41 formed by, for example, a halogen lamp. The heat source 41 is connected to anexternal power supply (not shown). Provided on the top wall of the chamber 40 is costing pipes 61 which are connected to the abovesaid costing tower.

The reaction chamber 10 and the heat source chamber 40 thermally intercommunicate through a window 43 made in, for example, quartz plate disposed therebetween.

The light source chamber 40 has a gas introducing pipe 44 which extends through its one end portion of the upper wall to the outside and is connected to abovesaid gas source 35 via the valve 36 and the flowmeter 37. The heat source chamber 40 has an exhaust pipe 48 which extends from its other end portion of the upper wall into the extending portion 10' of the reaction chamber 10. A heater 49 is provided on the exhaust pipe 48.

The reaction chamber 10 has attached thereto on the side of its extending portion 10' a substrate take-in/take-out chamber 70 with a shutter means 71 interposed therebeween. The shutter means 71 is

selectively displaced to permit or inhibit the intercommunication therethrough between the chambers 10 and 70.

The chamber 70 has another shutter means 72 on the opposite side from the shutter means 71. The chamber 70 has an exhaust pipe 73 which extends from its bottom to the vacuum system 22 via the aforementioned change-over valve 24. The chamber 70 has another pipe 75 which extends to the outside and terminates into the atmosphere via a valve 76.

The apparatus includes a conductive holder 81 for mounting a plurality of substrate members 90. The holder 81 is combined with thermally conductive press plates 82 for placing on the substrate members 90 mounted on the holder 81.

According to an example of the present invention, the abovesaid layer member is deposited on the substrate member 90 through use of such an apparatus, as described hereinafter.

Embodiment 1

A description will given of a first embodiment of the present invention for forming the layer member as a insulating layer member on the substrate member 90.

(1) The shutter means 71 between the reaction

chamber 10 and the substrate take-in/take-out chamber 70, the shutter means 72 of the chamber 70 a valve 76 between the chamber 70 and the outside, the valves 15A and 15B between the nozzle parts 12a and the gas sources 14A and 14B, the valve 19A, 19B and 19C between the nozzle parts 12b and the gas sources 18A, 18B and 18C and the valve 36 between the chambers 30 and 40 and the gas source 35 are closed.

(2) Next, the valve 23 between the reaction chamber 10 and the vacuum pump system 22 is opened and change-over valve 24 is also opened to the both chambers 10, 70, 30 and 40 to a pressure of 10_{-7} Torr.

(3) Next, the turbo pump 25 and the rotary pump 26 of the vacuum pump system 22 are activated, evacuating the chambers 10 and 70.

(4) Next, the valve 23 is closed and the change-over valve 24 is also closed relative to the both chambers 10 and 70, followed by stopping of the vacuum pump system 22 from operation.

(5) Next, the valve 76 is opened, raising the pressure in the chamber 70 up to the atmospheric pressure.

(6) Next, the shutter means 72 is opened, through which the substrate 90 mounted on a holder 81 with, its surface for the formation thereon of the

layer held down, is placed in the chamber 70 with a press plate 82 mounted on the substrate 90.

(7) Next, the shutter means 72 and the valve 76 are closed.

(8) Next, the change-over valve 24 is opened to the chamber 70 alone and the pump system 22 is activated, evacuating the chamber 70 to substantially the same vacuum as that in which the chamber 10 is retained.

(9) Next, the change-over valve 24 is closed relative to the both chambers 10 and 70 and then the pump system 22 is stopped from operation.

(10) Next, the shutter means 71 is opened, the holder 81 carrying the substrate 90 is moved from the chamber 70 into the chamber 10 and disposed at a predetermined position in the upper part of the chamber 10. At this time, the holder 81 is connected to the other end of the power source 15.

(11) Next, the shutter means 71 is closed.

(12) Next, the heat source 41 in the heat source chamber 40 is turned ON, heating the substrate 90 up to a temperature of 350 ℃.

(13) Next, the light source 31 in the light source chamber 30 is turned ON.

(14) Next, the valve 19A connected to the lower

nozzle part 12b of the nozzle 11 in the reaction chamber 10 is opened, through which ammonia gas (NH_3) is introduced as a first reactive material gas from the gas source 18A into the chamber 10. At the same time, the valve 23 is opened and the valve 24 is opened relative to the chamber 10 alone and, further, the pump system 22 is activated, raising the pressure in the chamber 10 to 3 Torr. Then the valve 15B connected to the upper nozzle parts 12a of the nozzle 11 is opened, through which disilane (Si_2H_6) is introduced as a second reactive material ga from the gas source 14B into the chamber 10 to provide therein a gas mixture of the ammonia gas and the disilane. The pressure in the chamber 10 is held at 3 Torr by regulating the valve 23. In this instance, exhaust pipes 38 and 48 between the chambers 30 and 40 and the reaction chamber 10 are heated by heaters 39 and 49 mounted thereon, respectively. Even if the gas mixture flows back from the reaction chamber 10 in the pipes 38 and 48 toward the chambers 30 and 40, it is vapor-decomposed by heat to deposit silicon nitride and silicon on the interior surfaces of the pipes 38 and 48, preventing the silicon nitride and silicon from deposition on the inside surfaces of the chambers 30 and 40. Furthermore, in order to prevent

such a reverse flowing of the gas mixture, the valve 36 is opened, through which nitrogen or argon gas is introduced from the gas source 35 into the chambers 30 and 40.

In such a condition, the gas mixture is excited by light from the light source 31 desposed in the light source chamber 31, by which it is excited and vapor-decomposed, depositing a first silicon nitride layer as a first insulating layer on the substrate 90 at a rate of 17A/min.

(15) Next, when the first silicon nitride layer is deposited to a thickness of about 500 A on the substrate 90, the valve 23 is regulated and when the pressure in the chamber 10 is reduced to 1 Torr, the power source 15 is turned ON and then the light source 31 is turned OFF.

In such a condition, the gas mixture of the ammonia gas and the disilane is discharged or excited by electric power from the power source 15 into a plasma, in consequence of which a second silicon nitride layer is deposited as a second insulating layer on the first silicon nitride layer at a rate 2.1 A/sec.

(16) Next, when the second silicon nitride layer is deposited to a thickness of about 0.5 μm, the

power source 15 is turned OFF and then the valves 15B 19A and 36 are closed but the valve 23 is fully opened, evacuating the chambers 10 and 30 to the same degree of vacuum as that under which the chamber 70 is held.

(17) Next, the valve 23 is closed and the pump system 22 is stopped and then the shutter means 71 is opened, through which the holder 81 carrying the substrate member 90 with the first and second insulating layers deposited thereon in this order is moved from the chamber 10 to the chamber 70.

(18) Next, the shutter means 71 is closed and then the valve 76 is opened, through which the prssure in the chamber 70 is raised to the atmospheric pressure.

(19) Next, the shutter means 72 is opened, through which the holder 81 is taken out to the outside and then the substrate member 90 having formed thereon the first and second insulating layers is removed from the holder 81.

In the manner described above, the insulating layer member as the layer member is formed on the substrate 90.

(20) Next, the holder 81 with no substrate member 90 mounted thereon is placed in the chamber

70, after which the shutter means 72 and the valve 76 are closed, the valve 24 is opend to the chamber 70 and the vacuum pump system 22 is put in operation, evacuating the chamber 70 to the same degree of vacuum as that under which the chamber 10 is retained.

(21) Next, the valve 24 is closed ralative to the both chamers 70 and 10, after which the shutter means 71 is opened, through which the holder 81 is placed in the chamber 10, and then the shutter means 71 is closed.

(22) Next, the valve 19B connected to the lower nozzle parts 12b of the nozzle 11 is opened, through which nitrogen fluoride (NF_3) is introduced as a first cleaning gas form the gas source 18B into the chamber 10. On the other hand, the valve 23 is opened and the valve 24 is opened to the chamber 10 and then the pump system 22 is put in operation, holding the pressure in the chamber 10 at 0.1 Torr.

(23) Next, the power source 15 is turned ON.

In such a condition, the first cleaning gas is discharged or excited into a plasma by electric power from the power source 15, etching away unnecessary layers deposited on the inside surface of the chamber 10, the inside surfaces of the windows 33 and 34, the

outside surface of the nozzle 11 and the outside surface of the holder 81. The unnecessary layers are composed of the materials of abevesaid first and second insulating layer.

(24) Next, when the unnecessary layers are almost etched away, the power source 15 is turned OFF and the valve 19B is closed, but the valve 19C is opened, through which hydrogen as a second cleaning gas, supplied from the gas source 18C, is introduced into the chamber 10, maintaining the pressure therein at 0.1 Torr.

(25) Next, the power source 15 is turned ON again. The second cleaning gas is discharged or excited into a plasma by electric power from the power source 15, cleaning the interior of the reaction chamber 10 including the windows 33 and 34, the nozzles 11 and the holder 81.

(26) Next, the power source 15 is turned OFF, after which the valve 19C is closed and the valve 23 is fully opened, through which the chamber 10 is evacuated. When the chamber 10 is evacuated to the same degree of vacuum as that under which the chamber 70 is retained, the valve 23 is closed, stopping the pump system 22 from operation.

Thus a series of steps for forming an insulating

layer member as a layer member on a substrate is completed.

Embodiment 2

Next, a description will be given of a second embodiment of the present invention for forming a semiconductor layer member as a layer member on a substrate.

This embodiment forms an amorphous silicon layer as the semiconductor layer member on the substrate 90 by the same steps as those in Embodiment 1 except the following steps.

(12') In step (12) in Embodiment 1 the heating temperature of the substrate 90 is changed from 350 C to 250 C.

(14') In step (14) of Embodiment 1 only the disilane (Si_2H_6) gas is introduced into the chamber 10 and the pressure in the chamber 10 is changed from 3 Torr to 2.5 Torr. A first amorphous silicon layer is deposited as a first semiconductor layer on the substrate 90.

(15') In step (15) of Embodiment 1, when the first amorphous silicon layer, instead of the first silicon nitride layer, is deposited about 1000 A thick on the substrate member 90, the disilane is discharged or excited into a plasma in place of the

gas mixture of the ammonia and disilane, by which a second amorphous silicon layer is deposited as a second semiconductor layer on the first amorphous silicon layer.

(16') In step (16) of Embodiment 1, when the second amorphous silicon layer, instead of the silicon nitride layer, is deposited about 1000 A, the power source 15 is turned OFF.

Embodiment 3

Next, a description will be given of a third embodiment of the present invention which forms an aluminum nitride (AlN) layer member as a insulating layer member on a substrate.

Embodiment 3 employs a same steps as those in Embodiment 1 except the following steps.

(14') In step (14) of Embodiment 1 methyl aluminum ($Al(CH_3)_3$), instead of the disilane, is introduced from the gas source 14A into the chamber 10, whereby a first aluminum nitride (AlN) layer is deposited as a first insulating layer on the substrate 90. In this case, the deposition rate of the first aluminum nitride layer is 230 A/min.

(15') In step (15) of Embodiment 1 a second aluminum nitride layer, instead of the second silicon nitride layer, is deposited on the first aluminum

nitride layer.

While in the foregoing the present invention has been described in connection with the cases of forming an insulating layer member having two insulating layers of the same material and a semiconductor layer member having two semiconductor layers of the same material, it is also possible to form an insulating layer member which has two insulating or protecting layers of different materials selected from a group consisting of, for example, si_3N_4, SiO_2, phosphate glass, borosilicate glass, and aluminum nitride. Also it is possible that an insulating or protecting layer of, for instance, the abovesaid insulating or protecting material and a conductive layer of such a metal as aluminum, iron, nickel or cobalt are formed in this order or in the reverse order to form a composite layer member. Furthermore, a semiconductor layer of a material selected from the group consisting of, for example, Si, Si_xC_{1-x} (where $0 < x < 1$), SiM_x (where $0 < x < 4$ and M is such a metal as Mo, W, In, Cr, Sn or Ga) and the abovesaid insulating or protecting or conductive layer can also be formed in this order or in the reverse order to obtain a composite layer member. Moreover, although in the foregoing a low pressure mercury lamp is

employed as the light source, an excimer laser (of a wavelength 100 to 400 nm), an argon laser and a nitrogen laser can also be used.

It will be apparent that many modifications and variations may be effected with out departing from the scope of the novel concepts of the present invention.

WHAT IS CLAIMED IS:

1. A method of forming a layer member on a substrate, comprising the steps of:

depositing a first layer on the substrate by a photo CVD process in a reaction chamber; and

depositing on the first layer by a plasma CVD process in the reaction chamber, a second layer of a material which is the same as or different from the material of the first layer.

2. A method of forming a layer member on a substrate according to claim 1, further comprising the step of cleaning the reaction chamber by plasma etching before the first layer depositing step or after the second layer depositing step.

D[illegible]ATION FOR UNITED STATES PAT[illegible]PLICATION

Docket No. _____

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled, LAYER MEMBER FORMING METHOD

the [illegible]ecification of which:

(check one) [X] is attached hereto.
[ ] was filed on _____ as Appl. Serial No. _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	PRIORITY CLAIMED
250340/84	Japan	26 November 1984	[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code, 120 of the United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

App[illegible]cation Serial No. _____ Filing Date _____ (Status: [ ] Patented [ ] Pending [ ] Abandoned)

App[illegible]cation Serial No. _____ Filing Date _____ (Status: [ ] Pending [ ] Patented [ ] Abandoned)

App[illegible]cation Serial No. _____ Filing Date _____ (Status: [ ] Pending [ ] Patented [ ] Abandoned)

I hereby appoint MURRAY, WHISENHUNT and FERGUSON, Waterview Building, 1925 N. Lynn Street, Arlington, VA 22209, Telephone No. (703) 243-0400 (to whom all communications are to be addressed), the partners thereof, Robert B. Murray, Reg. No. 22,980, Fred S. Whisenhunt, Reg. No. 24,378 and Gerald J. Ferguson, Jr., Reg. No. 23,016, and the associates thereof, individually and jointly my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and with the resulting patent.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(Attach second page when needed for further joint inventors, if any)